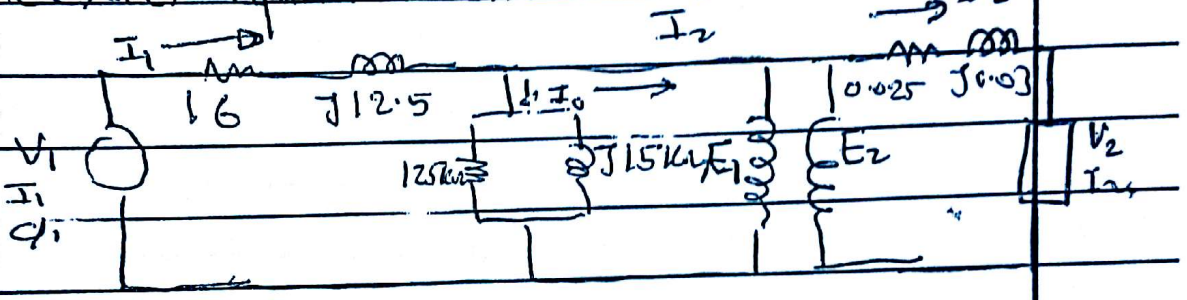
2/4/2017

Tutorial #2 EE352

Q1 50 KVA, 50 Hz supply, 2200/132V single phase transformer with a (16+J12.5) primary impedance and (0.025+j0.03) secondary impedance. The primary side shunt has (125KΩ) core resistance and (J15KΩ) magnetizing reactance. Find

(a) The exact equivalent circuit



(b) The maximum primary induced emf1 for rated load at 132 V and 0.85 lagging PF.

$E_1 = ?$ $\Rightarrow E_1 = E_2 \times \frac{V_1}{V_2}$

$E_2 = V_2 + I_2 Z_2$, $I_2 = \frac{50\text{KVA}\ \angle -\cos^{-1}0.85}{132}$

$$I_2 = 378.78\ \angle -31.79 \longrightarrow (1)$$

$$E_2 = 132\ \angle 0 + (378.78\ \angle -31.79)(0.025+j0.03)$$

$$E_2 = 146.45\ \angle 1.87 \longrightarrow (2)$$

$$E_1 = E_2 \times \frac{V_1}{V_2} = 146.45\ \angle 1.87 \times \frac{2200}{132} = 2441\ \angle 1.8\ \text{(RMS)}$$

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$E_{1max} = \sqrt{2}\, E_{rms} = 3452\ V$

(c) The supply voltage for the same operating conditions:

$V_1 = E_1 + I_1 Z_1$.

$I_1 = I_0 + I_2'$, $I_2' = I_2/a = 22.72 \angle -31.79$ A.

$I_0 = \frac{E_1}{(j15k\Omega // -j25k\Omega)} = 0.1634 \angle -81.328$

$I_1 = I_2 + I_0 = 22.836 \angle -32.27$ A.

$V_1 = 2441 \angle 1.87 + (22.836 \angle -32.27)(20.3 \angle 38)$

$\boxed{V_1 = 2897 \angle 2.8^\circ}$

(d) The maximum flux established per turn:

$E_1 = 4.44\, \Phi_{max}\, f\, N_1$

$\frac{\Phi_{max}}{turn} = \frac{E_1}{4.44 f N_1} = \boxed{\frac{10.96\ mb}{N_1\ t}}$

OR

$\boxed{\frac{\Phi_{max}}{turn} = \frac{E_2}{4.44 f N_2}}$

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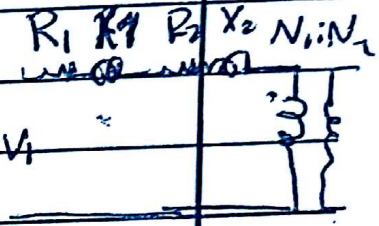
100KVA transformer has 400 turn on the primary and 80 turns on the Secondary. The primary and Secondary resistances are 0.3Ω, $R_2 = 0.01\Omega$ and corresponding leakage reactance's are 1.1Ω and 0.035Ω. The Supply Voltage is 9200V. The iron loss is 600 watt Calculate.

(a) The equivalent impedance referred to primary

$$a = \frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{80}{400} = \frac{1}{5}$$

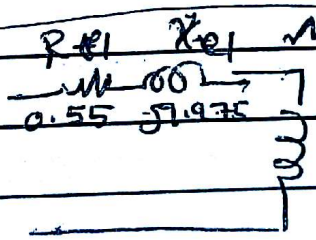


$$R_2' = \frac{R_2}{a^2} = \frac{0.01}{(1/5)^2} = 0.22\Omega.$$

$$\therefore R_{e1} = R_1 + R_2' = 0.22 + 0.3 = 0.55\Omega$$

$$X_2' = \frac{X_2}{a^2} = \frac{0.035}{(1/5)^2} = 0.875\Omega.$$

$$\therefore X_{e1} = X_1 + X_2' = 0.875 + 1.1 = 1.975\Omega$$



$P_{iron} = 600$ watt

$P_{cu} = I_1^2 R_{e1} = I_2'^2 R_e$

(b) The efficiency at full load and 0.8 PF lagging.

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$I_1 = \frac{100000}{2200} = 45.45\ A.$

$P_{cu} = I_1^2 R_{e1} = (45.45)^2 \cdot (0.55) = 1136.363\ Watt.$

or by eq

$\eta = \frac{S\cos\theta}{S\cos\theta + P_i + P_{cu}} = \frac{80000}{80000 + 600 + 1136.36}$

$\eta = 0.978 \Rightarrow \eta\% = 97.8\%$

(e) The maximum efficiency at 0.9 PF leading

$n = \sqrt{\frac{P_i}{P_{cu}}} = \sqrt{\frac{600}{1136.363}} = 0.7266$

$\eta_{max} = \frac{n \times S\cos\theta}{n \times S\cos\theta + 2P_i} = \frac{0.7266 \times 100 \times 10^3 \times 0.9}{0.7266 \times 100 \times 10^3 \times 0.9 + 1200}$

$\eta_{max} = 0.9819. \Rightarrow \eta_{max}\% = 98.19\%$

d) The voltage regulation at full load and (0.8 lagging and 0.9 leading)

$\epsilon\% = \frac{I_1 (R_{e1}\cos\phi \mp X_{e1}\sin\phi)}{V_1} \times 100$

For lagging 0.8 PF.

$\epsilon\% = \frac{45.45 (0.55 \times 0.8 + 1.975 \times \sin\cos^{-1} 0.8)}{2200} \times 100$

$\epsilon\% = 3.357\ \%$

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For Leading 0.9 pf

$$\%\varepsilon = \frac{45.45 \times (0.55 \times 0.9 - 1.975 \sin(\cos^{-1} 0.9))}{2200}$$

$$\%\varepsilon = -0.7558\ \%$$

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